

Remarks

The above amendments and these remarks are responsive to the Office Action mailed September 14, 2005. With entry of this amendment, claims 1-25 are pending. No new matter has been added by these amendments.

Applicants thank the Examiner for carefully considering the subject application. Before discussing this issue, Applicants believe it may be helpful to quickly review some background information.

Background

The present application relates to multi-stroke engine operation (for example, 2-stroke, 4 stroke, 6-stroke, or 12-stroke), which is one method that may improve fuel economy while maintaining reserve torque capacity for elevated load conditions. During multi-stroke operation, selected strokes of each cylinder may not follow a typical four-stroke cycle for some conditions but rather perform extra compression strokes, for example. Operating an engine in this fashion can also provide various other advantages, as described in the specification.

The approach of Richeson notes the use of multi-stroke operation at Col. 15, lines 26-30, for example. Specifically, it states that “six-stroke cycle, two-stroke cycle, and operation as a conventional throttled engine are available under the computer control of the present invention.”

However, as noted in the application as filed, the inventors herein have recognized several issues with using multi-stroke operation. For example, use of multi-stroke operation during low engine load conditions may require a reduced inducted cylinder; but, electromechanical valve constraints may make it difficult to control lower cylinder air amounts because the valves may have a minimum open time that is related to the valve inertia and to the actuator coil construction. Further, under some conditions, there may be insufficient charge motion (i.e., swirl and tumble) to provide the desired combustion characteristics.

Claim 1

Unlike the prior art, the approach of claim 1 takes advantage of different valve patterns under different conditions of multi-stroke operation. Specifically, it states:

A method for controlling valve patterns of valves in at least a cylinder operating in a multi-stroke mode of an internal combustion engine, the method comprising:

operating a first valve pattern in said cylinder operating in multi-stroke mode during at least a first engine operating condition; and

operating a second valve pattern, different from said first valve pattern, in said cylinder operating in multi-stroke mode during a second engine operating condition, said second operating condition different from said first operating condition; wherein the difference between said first valve pattern and said second valve pattern is at least one of a number of operating valves per cylinder and a region of operating valves in the cylinder.

As described in the specification, a different number of valves may be used, such as two intake valves under some conditions and one intake valve under other conditions. Alternatively, two exhaust valves may be used under some conditions and one exhaust valve under other conditions. Alternatively, or in addition, valves may be operated in different regions. For an example of a first and second valve pattern, see Figures 25-26, for example.

In one example, under some conditions of multi-stroke operation, two intake valves per cylinder may be used, but under other conditions, such as low flow conditions, one intake valve per cylinder may be used to provide a greater degree of low flow regulation. In another example, under some conditions an intake and exhaust valve positioned in diagonal regions may be used to generate increased charge motion at low loads, whereas under other conditions intake and exhaust valve positioned across from one another may be used for less charge motion. These are just two examples, as many others are also possible, such as described in Applicants' specification.

Richeson

As noted above, Richeson mentions multi-stroke operation at Col. 15. However, Applicants have reviewed Richeson and can find no disclosure of using different valve patterns under different conditions in multi-stroke operation, where the difference between said first valve pattern and said second valve pattern is at

least one of a number of operating valves per cylinder and a region of operating valves in the cylinder.

As such, Applicants respectfully request that the rejection of claim 1 be withdrawn.

The above arguments also apply to each independent claim.

The above-identified application is believed to be in condition for allowance, and such allowance is courteously solicited. If any further amendment is necessary to advance prosecution and place this case in allowable condition, the Examiner is courteously requested to contact the undersigned by fax or telephone at the number listed below.

Please charge any cost incurred in the filing of this Amendment, along with any other costs, to Deposit Account No. 06-1510. If there are insufficient funds in this account, please charge the fees to Deposit Account No. 06-1505. A duplicate copy of this sheet is enclosed.

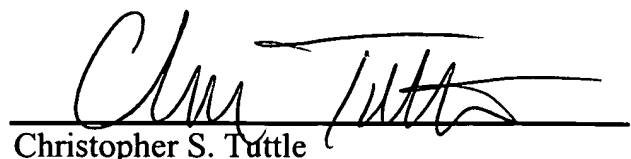
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I hereby certify that this correspondence is being sent via first class mail addressed to Mail Stop AMENDMENT, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on December 13, 2005



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